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DRAWINGS ATTACHED

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(54) GRINDING APPARATUS

(71) I, IETATSU OHNO, a Japanese subject, of 14-2-406, Mure, Mitaka City, Tokyo, Japan, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to grinding apparatus, particularly apparatus for grinding comparatively small objects of complicated shape such as, for example, watch parts, hosiery needles or injection needles.

Such objects are usually ground in an apparatus comprising a sealed container containing the objects to be ground and a suitable abrasive which is mounted on the periphery of a drum which is rotated at high speed. While the objects to be ground and the adbrasive are forced against each other by the centrifuagl force, a fine vibratory motion occurs and thus the grinding action takes place.

If in addition to the rotary motion given by the drum, the containers also have a rotary motion about their own axes there will be a flow movement within the containers due to the tendency of the objects and abrasive to move towards the periphery of the container under the influence of the centrifugal force. This provides additional friction between the objects to be ground and the abrasive and thus improves grinding efficiency.

It is therefore an object of the present invention to provide a grinding apparatus in which a complex motion is imparted to the objects to be ground and the abrasive to thereby increase the grinding efficiency.

Accordingly, the present invention provides a grinding apparatus comprising a rotary drum mounted on a main shaft fixed onto a base, a plurality of cylindrical or polygonal containers each mounted on the drum by a rotary shaft disposed parallel to said main shaft with the longitudinal axes of each container inclined to its rotary shaft, drive means and transmission means whereby the drum is caused to revolve and the containers to rotate relative to the drum so that the objects to be ground and abrasive contained in the containers are caused to move in a path having the form of a figure 8.

The invention will now be described with reference to an embodiment illustrated in the accompanying drawings in which:—

Figure 1 is a side view of a grinding apparatus according to the present invention;

Figure 2 is a vertical sectional view on line II—II in Figure 1;

Figure 3 is an end view of Figure 1;

Figure 4 is a vertical sectional view on line IV—IV in Figure 1;

Figures 5a to 5d are sectional views respectively on lines C—C, D—D, E—E and F—F in Figure 4;

Figure 6 is a view showing the directions of motion of the abrasive in the container;

Figure 7 is a vertical sectional view of Figure 6 and

Figures 8a to 8h are sectional views illustrating how abrasives and objects to be ground contained in a cylindrical container flow in the form of a figure 8.

Referring now to Figures 1 to 3, a rotary drum 3 comprising two discs 3 and 4 connected by a shaft 6 is mounted on a base 1 by means of a main shaft 2, fixed to vertical portions of the base 1, lying loosely within the shaft 6. For rotating the drum, there is provided on one disc 4 a pulley 7 which is driven by a belt 10 connected to a pulley 9 on a motor 8. The drum may be rotated at a speed, for example, of 200 r.p.m.

Four rotary shafts 11 having axes lying in planes parallel to a plane containing the axis of the main shaft 2 are rotatably fitted to the periphery of the drum between the discs 3 and 4. A cylindrical or polygonal 12 is mounted on each of the shafts 11 with its longitudinal axis inclined to the axis of rotation. An opening in each container is provided with a lid 13 secured by any suitable means. A gear wheel 14 is fixed to each shaft 11 to mesh with a respective gear wheel 15 journalled on the outside of disc 5.

A gear wheel 16 meshing with the four gear wheels 15 is fixed to a shaft 24 journalled

[Price 25p]

onto main shaft 2. A forked member 17 secured by a pin 18 fixed to a vertical portion of the base 1 is supported by the shaft 24. A rod 19 having an opposedly threaded portion 20 is screwed through the prongs of the forked member 17 so that when the rod 19 is rotated by means of a handle 21 the distance between the prongs either increases or decreases, depending upon the direction of rotation. Thus the forked member 17 and the rod 19 act as a brake so that the shaft 24 may rotate when the distance between the prongs is increased or be fixed when it is decreased.

The apparatus operates as follows. The lid 13 is removed from the container, abrasive 22, objects 23 and a suitable amount of water are placed in the container 12 and the lid 13 is then replaced. To enable this to be done the shaft 24 is released by the forked member 17 so that each container can rotate indepently of the drum and be brought into a position with the opening and lid at the top of the container. When the containers have been filled the shaft 24 is gripped by the forked member 17 and the drum 3 is rotated in the direction indicated by the arrow *p* in Figure 2, the gear wheels 14 and 15 will then rotate respectively in the direction indicated by the arrows *r* and *q*. If the diameters of the gear wheels 16, 15 and 14 are the same, then with one rotation of the drum 3 the gear wheel 14 will rotate once in the direction indicated by the arrow *r*. That is to say, as shown in Figure 4, when the drum 3 revolves in the direction indicated by the arrow *p* and the container 12 rotates around the shaft 11, said container 12 will rotate at the same angular velocity in the direction indicated by the arrow *r*. Further, the abrasive 22 and objects 23 to be ground within the cylindrical or polygonal container 12 always tend to move in the outer peripheral direction of the container due to the centrifugal force of the rotation of the container. Therefore, within the container 12, the abrasive 22 and objects 23 flow in the direction indicated by the arrow *s* in Figure 4.

As the container 12 rotates in the direction indicated by the arrow *r* and moves with the rotation of the drum 3, the contents of the containers will at different instants take up the positions shown in Figures 4 and 5. Thus as is shown in Figure 5, the abrasive 22 and the objects 23 to be ground always tend to be positioned near the periphery of the drum 3 due to centrifugal force. Therefore, the abrasive and the objects to be ground tend to move in the directions indicated by the arrows *t*, *u*, *v* and *w* (Figures 5a to 5d) within the container 12, i.e., in a path having the form of a figure 8 as is shown in Figure 6.

Thus in the apparatus according to the present invention with each container having its axis inclined to the rotary shaft 11, the flow within each container is a combination of the movement in a peripheral direction and in a path in the form of a figure 8. The combination of some of such movements are indicated in Figure 7 and it will be seen that a complex flow pattern is achieved for the objects to be ground and the abrasive.

This complex movement together with the rotary movement imparted by the rotation of the drum increases the grinding efficiency and enables objects of complicated shape to be uniformly ground.

A disadvantage of conventional grinding apparatus is that when grinding such objects as thin plates, the plates are held together by the surface tension of the water used with the abrasive and therefore the adhering faces are not ground. With the apparatus according to the present invention however any such objects would inevitably become separated owing to the complexity of the motion and would be uniformly ground over the entire surface.

In the embodiment described the angular velocity of the rotation of the containers 12 and the angular velocity of the revolution of the drum 3 are the same, however, they may be different and this can be achieved, for example, by selecting appropriate sizes for the gear wheels 14, 15 and 16. It is also possible for the containers to be divided into several coaxial compartments, forming in effect several containers within one container.

WHAT I CLAIM IS:—

1. A grinding apparatus comprising a rotary drum mounted on a main shaft fixed onto a base, a plurality of cylindrical or polygonal containers each mounted on the drum by a rotary shaft disposed parallel to said main shaft with the longitudinal axes of each container inclined to its rotary shaft, drive means and transmission means whereby the drum is caused to revolve and the containers to rotate relative to the drum so that the objects to be ground and abrasive contained in the containers are caused to move in a path having the form of a figure 8.

2. A grinding apparatus according to claim 1, wherein the transmission means comprises a gear wheel on each of the rotary shafts, gear wheels journalled onto a disc of the drum and a gear wheel mounted on a shaft coaxial with the main shaft meshing with one another and a brake mechanism whereby said coaxial shaft is held or released for rotation

of the containers independently of the drum rotation.

3. A grinding apparatus substantially as herein described with reference to and as illustrated in the accompanying drawings.

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1249056 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 1

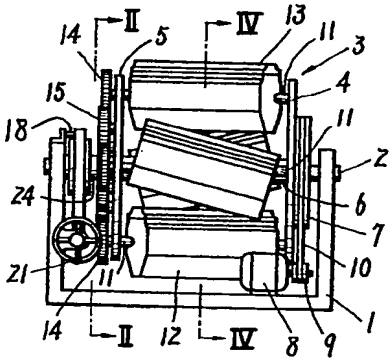


Fig. 2

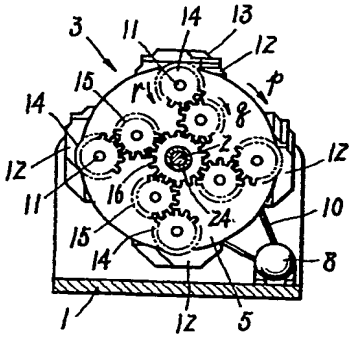


Fig. 3

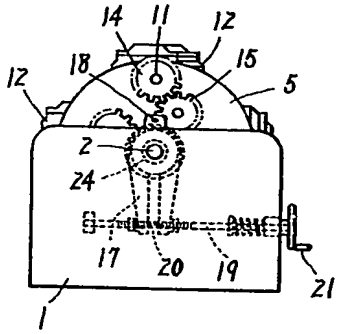


Fig. 4

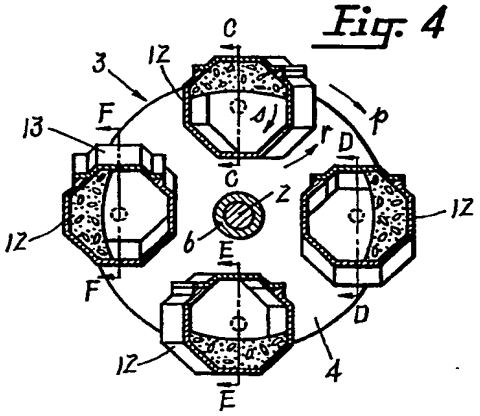


Fig. 5a

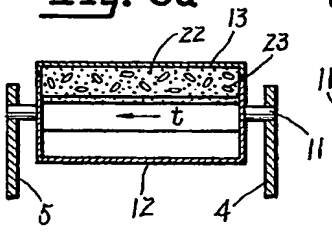


Fig. 5b

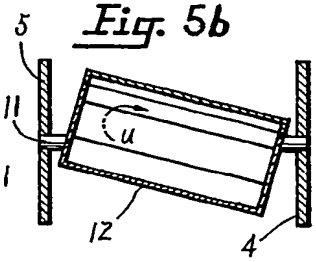


Fig. 5c

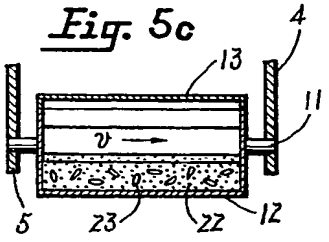
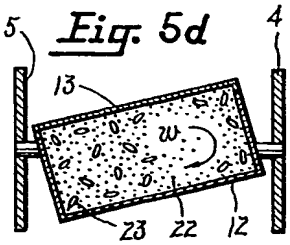


Fig. 5d



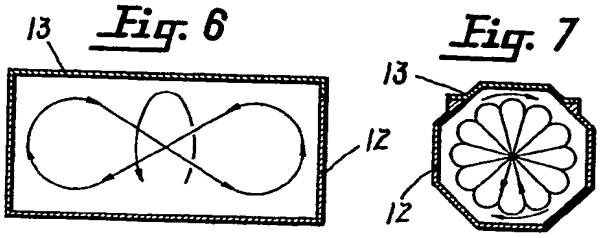


Fig. 6

Fig. 7

Fig. 8a

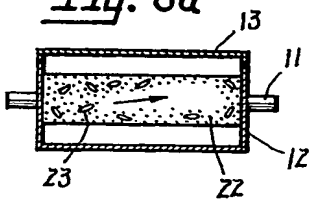


Fig. 8b

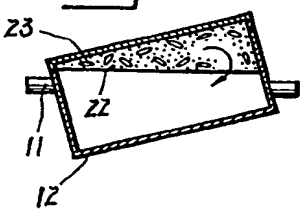


Fig. 8c

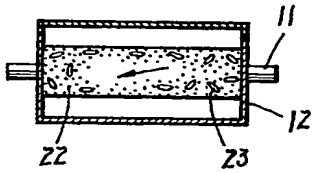


Fig. 8d

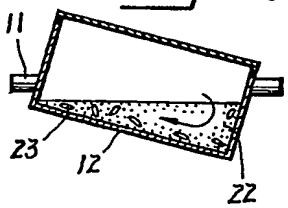


Fig. 8e

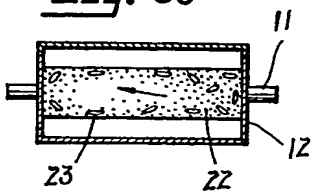


Fig. 8f

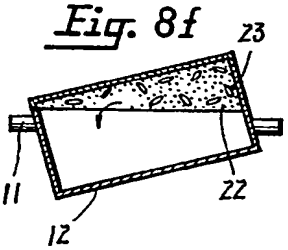


Fig. 8g

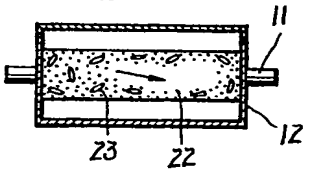


Fig. 8h